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A Test of Heeling-in to Harden Stock for Frozen Overwinter Storage in Polybags and Kraft Bags

by

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In the fall of 1970 a test was started at Orono Nursery to study heeling-in as a possible aid to hardening trees for frozen overwinter storage. There were 8 weekly liftings from October 14 to December 3 for each of the species, red pine (*Pinus resinosa* Ait.), white pine (*Pinus strobus* L.) and white spruce (*Picea glauca* (Moench) Voss). At each lift, half of the trees were placed immediately in frozen storage at -3°C and the remainder heeled-in for one week after which they were lifted and stored. There were two types of containers: 1/ the normal Kraft bag (double-walled paper with polyethylene layer on inside), and 2/ a large Polybag (4 mil semi-opaque polyethylene, 0.8 m^3 peat container).

In the spring of 1971, samples were obtained from the same nursery beds for freshly-lifted controls in the two plantings. These were lifted May 11 for the first planting tests which were established on May 12 to 15 using half of the stored material. The second lot of control stock was lifted on May 31 for plantings on June 1 to 7. The stock characteristics are summarized in Table 1.

TABLE 1 Characteristics of 3+0 stock, fall lifting (1970) for overwinter storage and spring lifting (1971) for planting controls

	Top length (cm)	Stem diameter (cm)	Oven-dry weight (g)	Top:root ratio
Red pine				
Fall	20.5	.41	5.33	6.14
Spring	19.7	.40	6.12	5.65
			(large 4.51-6.00)	(3.0-5.0)[a]
White pine				
Fall	18.3	.45	4.90	3.17
Spring	17.8	.40	4.87	3.67
			(large 4.51-6.00)	(1.8-3.8)
White spruce				
Fall	26.1	.46	5.22	3.92
Spring	24.7	.40	4.40	3.98
			(very large: over 4.00)	(2.5-4.5)

[a] Figures in brackets are dry weight size classes, and working ranges of top:root ratios from Armson and Carman (1961).

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The field tests were established at Midhurst Research Centre (95 km north of Toronto) and in Gurd Township (about 175 km north of the above planting) near North Bay. The planting design consisted of 5 replications, with 9 randomized plots per replication and 100 trees per plot (based on 8 fall liftings and 1 spring lifting). Within each plot there were four randomized rows of 25 trees for each of the four treatments: Polybag, Kraft bag, heeled-in Polybag and heeled-in Kraft bag. At each location, there were adjacent early plantings (May 12-15) and late plantings (June 1-7) of each species. A total of 54 000 trees were planted in the test, all by the wedge method.

The planting at Midhurst is on a good quality, level, sandy loam site which had been cultivated prior to planting to remove competition. The site in Gurd Township is a well drained sandy and gravelly slope, a former pasture field with a moderate sod and herb cover.

The results of the planting tests are reported here in terms of survival percentages and total heights at the fifth year after planting.

Results and Discussion

The results at 5 years show considerable differences between the sites; survival at Midhurst is slightly lower than that at Gurd Township (71.8% versus 76.2%) but growth is considerably better (123.5 cm versus 82.6 cm average height). Nevertheless, similarities in performance according to treatment permit the following comments.

Heeling-in Prior to Storage. In the majority of the 36 statistical analyses (3 species x 2 planting times x 2 locations; for survival, heights and terminal lengths) the interaction of treatment by time of fall lifting was significant. This is illustrated in Table 2 for the red pine at Midhurst. Heeling-in was of benefit to the success of stock after storage in the early liftings in the fall. Leaving the trees outside for the additional week permitted continuation of the natural hardening-off process. Hence the nurseryman has the option of lifting

TABLE 2 Survival and total height at 5 years for early planting of red pine at Midhurst Research Centre showing significant interactions of heeling-in x time of lifting. (Survival at 0.01%, height at 0.01%)

Time of lift	Survival (%)				Total height (cm)			
	P[a]	K	PH	KH	P	K	PH	KH
Oct. 14	0	1.6	12.8	18.4	0	82	109	116
Oct. 22	3.2	36.0	25.6	52.0	80	113	107	124
Oct. 29	37.6	55.2	76.0	80.0	122	124	136	135
Nov. 5	50.4	68.0	52.0	58.4	117	134	122	126
Nov. 12	59.2	59.2	65.6	52.8	141	123	134	137
Nov. 19	67.2	68.8	81.6	81.6	131	135	139	136
Nov. 26	55.2	62.4	59.2	60.8	112	110	120	118
Dec. 3	69.6	76.8	76.8	76.0	149	134	135	142

[a] P = Polybag; K = Kraft bag; PH = Polybag, heeled-in; KH = Kraft bag, heeled-in.

before the stock has hardened-off or reached a suitable DHD (degree hardening days) for the species (Mullin and Parker 1976) if he is prepared for the extra work and expense of heeling-in.

Polybags Versus Kraft Bags. A comparison of the effectiveness of Polybags and poly-lined Kraft bags for storage was made in terms of aggregate height. For the 36 analyses (3 species x 2 planting times x 2 locations; for survival, heights and terminal lengths) it was found that performance of stock stored in the Kraft bag was better than that stored in the Polybag in 24 instances, statistically so in 6. In the overall average performance, the aggregate height at 5 years (Table 3) of stock stored in the Kraft bag was about 7% better than that of stock stored in the Polybag.

TABLE 3 Aggregate heights (planting density x survival percentage x average height) at 5 years, by species and containers for all treatments and locations

Species	Aggregate height (cm/ha)	
	Polybag	Kraft bag
Red pine	178 240	197 890
White pine	231 540	249 700
White spruce	194 160	197 000

Time of Fall Lifting. The effect of the time of fall lifting on the later performance of the stock was examined in terms of aggregate height. The data used pertained only to the Kraft bag treatment, in view of the findings reported above, and only to the early planting as being more typical of current field operations. The results confirmed earlier studies (Mullin and Parker 1976): the white spruce was ready for storage at an earlier date than the other two species. (Red and white pine were ready for storage between October 22 and 29, white spruce by October 14.)

The storage of red pine was found to produce uncertain results. There was much variation in performance, from 6.5% less than control for the Dec. 3 lift, to 35.4% less than control for Nov. 26. Other experiments have encountered similar problems with this species (Mullin and Bunting 1972, Mullin and Parker 1974). The cause of these large differences over time may be related to the greater susceptibility of this species to exposure damage.

Extended Season Planting. The effects of late planting of June 1-7, 2 or 3 weeks past the normal planting season, are shown in Table 4. The data are from the Kraft bag treatment only and for lifts after Nov. 5 as representative of normal planting and storage procedure. The comparison is made with the freshly lifted stock for each planting date.

TABLE 4 Comparison of aggregate heights at 5 years, for overwinter stored (Kraft only) stock and controls, by early (May 12-15) and late (June 1-7) plantings at both locations

Planting time	Aggregate heights (cm/ha)	
	Stored	Control
Red pine		
Early	249 579	325 678
Late	232 007	313 898
Decrease %	7.0	3.6
White pine		
Early	314 719	308 767
Late	288 430	216 799
Decrease %	8.4	29.8
White spruce		
Early	248 622	238 326
Late	185 345	201 918
Decrease %	25.4	15.3

In all instances the results show a reduction in growth due to late planting of both stored and fresh stock, ranging from 3.6% to 29.8%. In red pine and white spruce, fresh stock was better than stored stock for late planting whereas in white pine, stored stock was better than the fresh material.

References

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